

CLAIMS

1. A variable focus lens comprising a first fluid (A) and a second fluid (B), said fluids (A,B) having different indices of refraction, wherein the lens function of said variable focus lens can be selectively controlled, at least one of said fluids (A,B) being non-colourless, the lens further comprising
5 means for correcting for a colour change which would otherwise occur in an image of an object compared with the object itself as a result of said non-colourless fluid.
2. A lens according to claim 1, wherein said colour change
10 correcting means comprises a dye or similar pigmentation material added to the non-colourless fluid (A) to counteract the effect thereof on the colour of the image.
3. A lens according to claim 1 or claim 2, wherein said colour
15 change correcting means comprises colour filter means placed in the lightpath (100) to counteract the effect of said non-colourless fluid (A) on the colour of the image.
4. A lens according to any one of claims 1 to 3, wherein said colour
20 change correcting means comprises a dye or similar pigmentation material added to the fluid (B) other than the non-colourless fluid (A).
5. A lens according to claim 4, wherein the dye or other
25 pigmentation material has substantially the same level and type of colour absorption as the non-colourless fluid (A).

6. A lens according to any one of claims 1 to 5, wherein the inner wall of said fluid chamber (5) is shaped such that the thickness of the non-colourless fluid layer is substantially the same, irrespective of the shape of the meniscus (14).
- 5 7. A lens according to any one of claims 1 to 6, wherein the non-colourless fluid is a liquid having an index of refraction greater than 1.5.
8. A lens according to claim 7, wherein the index of refraction of
10 said non-colourless fluid is greater than 1.7.
9. A lens according to claim 7 or claim 8, wherein the non-colourless fluid comprises an oil having a refractive index greater than 1.5.
- 15 10. A lens according to claim 11, wherein the non-colourless fluid has a refractive index greater than 1.7.
11. A lens according to any one of the preceding claims, wherein said non-colourless fluid is yellow, red or brown.
- 20 12. A lens according to any one of claims 1 to 11, wherein the second fluid (B) is axially displaced from the first fluid (A), the fluids (A,B) being in contact over a meniscus (14), the lens further comprising a first electrode (2) and a second electrode (12), wherein the shape of the
25 meniscus (14) can be controlled in dependence on the application of a voltage between the first electrode (2) and the said second electrode (12).
13. A lens according to claim 12, comprising a substantially cylindrical fluid chamber (5), and a fluid contact layer (10) arranged on the
30 insiee of the cylinder wall.

14. A lens according to claim 13, wherein the first electrode (2) is separated from the first fluid (A) and the second fluid (B) by the fluid contact layer (10), and the second electrode (12) is arranged and configured to act on the second fluid (B).

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15. A lens according to claim 13 or claim 14, wherein the fluid contact layer (10) is arranged to have a wettability by the second fluid (B) which varies under the application of a voltage between the first electrode (2) and the second electrode (12), such that the shape of the meniscus (14) varies in dependence on the said voltage.

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16. A lens according to any one of claims 13 to 15, wherein the wettability of the fluid contact layer (10) by the second fluid (B) is substantially equal on both sides of the intersection of the meniscus (14) with the fluid contact layer (10) when no voltage is applied between the first and second electrodes (2,12).

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17. A lens according to any one of claims 13 to 15, wherein the first fluid (A) includes an insulating fluid and the second fluid (B) includes a conducting liquid.

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18. A lens according to any one of claims 1 to 12, comprising a chamber (125) defined by at least one side wall having an optical axis (90) extending longitudinally through the chamber (125), wherein the chamber (125) contains the fluids (A,B), which are in contact over a meniscus (150), the lens further comprising at least one pump (110) for altering the relative volume of each of the fluids (A,B) contained within the chamber (125).

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19. A lens according to claim 18, wherein the perimeter of the meniscus (150) is constrained by the side wall, and the at least one pump (110) is arranged to controllably alter the position of the meniscus (150) along

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the optical axis by altering the relative volume of each of the fluids (A,B) contained within the chamber (125).

20. A lens according to claim 18, wherein the perimeter of the
5 meniscus (150) is fixedly located on an internal surface of the chamber (125) and the at least one pump (110) is arranged to controllably alter the shape of the meniscus (150) by altering the relative volume of each of the fluids (A,B) contained within the chamber (125).

10 21. A lens according to any one of claims 18 to 20, wherein the wettability of the internal surface of the chamber (125) varies longitudinally, and is arranged to be controllably altered by the electrowetting effect.

22. A lens according to any one of claims 1 to 12, arranged to
15 provide a variable zoom setting for a beam of readiation, and comprising a switchable optical element having a first mode and a second mode, the element including the first fluid (A), the second fluid (B) and a wavefront modifier (26) having a part (28) through which the radiation is arranged to pass, where in the first mode, the switchable optical element has a first fluid
20 configuration in which the part (28) is substantially covered by the first fluid (A) and in a second mode, the switchable optical element has a second different, fluid configuration in which the part (28) is substantially covered by the second fluid (B).

25 23. A lens according to claim 22, wherein the switchable optical element (34) comprises a common first fluid electrode (50), a second different fluid electrode (34) and a third, different, fluid electrode (40), wherein in the first fluid configuration, the element is arranged to provide switchable electrowetting forces by applying a first voltage across the first (5) and
30 second (34) fluid electrodes, and in the second fluid configuration, the element is arranged to provide different switchable electrowetting forces by

applying a second, different voltage across the first (50) and third (40) fluid electrodes.

24. An optical system including a variable focus lens comprising a
5 first fluid (A) and a second fluid (B), the fluids (A,B) having different indices of
refraction, wherein the lens function of the variable focus lens can be
selectively controlled, at least one of said fluids being non-colourless so as to
absorb at least a portion of a light beam passing therethrough and causing a
colour change in an image of an object compared with the object itself, the
10 optical system further comprising means for correcting for said colour
change.

25. An optical system according to claim 24, comprising an electronic
image sensor, wherein means are provided for electronically adjusting the
15 white balance of the image so as to counteract the effect on the colour
thereof by the non-colourless fluid (A).

26. An optical system according to claim 24 or claim 25, arranged
and configured such that the stop thereof is relatively close to the position of
20 the meniscus (14) between the first fluid and the second fluid.

27. An optical system according to any one of claims 24 to 26,
incorporating a variable focus lens according to any one of claims 2 to 16.

25 28. An image capture device including a variable focus lens
according to any one of claims 1 to 16, or an optical system according to any
one of claims 24 to 27.

29. An optical scanning device for scanning an optical record carrier,
30 the optical scanning device including a variable focus lens according to any
one of claims 1 to 23, or an optical system according to any one of claims 24
to 28.